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OBSERVATIONS *on* COAL-MINES.

By RICHARD KIRWAN, *Eſq*; *M.R.I.A. and F.R.S.*

Read Jan. 10, 1789.

IN travelling through different parts of the kingdom laſt ſummer, it was with pleaſure I obſerved the attention of many of the principal landholders awakened to reſearches after minerals, a ſpecies of riches with which I have reaſon to think Ireland is well ſupplied, though few of them have as yet been worked with national advantage. In conſequence of this attention, ores of copper, lead, and iron of the beſt kind, have been already found in different provinces; but the want of fuel has hitherto prevented the proprietors from reaping the full benefit of their diſcoveries, ſuch ores as lie in the interior parts of the kingdom being utterly neglected, and thoſe ſituated near the ſea being generally tranſported to England. It is therefore evident that of all minerals the moſt neceſſary at preſent is pit-coal; its uſes extending not only to the purpoſes of metallurgy, but to thoſe of of many other manufactures, as well as to ſupplying the immenſe conſumption of the capital. It is a happy circumſtance that the obſervations that lead to its inveſtigation are, of all others, the leaſt fallible and ambiguous. To collect theſe, I have peruſed all thoſe hitherto made on coal-mines, and the ſtrata that uſually accompany them. The moſt important, and which may ſerve to guide us in our reſearches, being but few, and perhaps not generally known, at leaſt in this kingdom, I take the liberty of laying before the Academy, to which every attempt to promote the public utility, however deſtitute of merit in other reſpects, cannot fail of being acceptable.

General Obſervations.

When we conſider the interior conſtruction of mountains, hills or plains, and the materials of which they conſiſt, we are eaſily led to acknowledge not only that the greater part were formed in water, but that ſome of them are of later formation than others. Thus ſome are formed of huge ſhapeleſs maſſes, without any regular fiſſures; but if theſe maſſes be attentively inſpected, they will be found to conſiſt of ſmall grains of ſtones, of different ſorts, concreted together, and hence called *granites*; the exact adaption of theſe grains to each other, and the regular cryſtallized ſhape of ſome of them, ſhew that they muſt have been originally in a ſoft or even in a fluid ſtate; their continuity, and want of regular fiſſures, indicate their ſimultaneous concretion; the ſuperior difficulty of their ſolution at preſent, and the immenſe ſpace they occupy in the globe, of which they conſtitute

conſtitute as if it were the kernel, and the total abſence of all organic remains, induce us to think that of all others they are the moſt antient. Other hills or mountains conſiſt of ſtony maſſes, apparently homogeneous, at leaſt for the greater part, but ſeparated from each other by fiſſures parallel to each other; theſe are moſtly of an argillaceous or calcareous nature, and appear to have been formed by a gradual ſubſidence from water, in which they were originally ſuſpended. As no organic remains are found in them, they alſo ſeem to date their origin from the formation of the globe.

FROM the decompoſition of theſe primæval maſſes, their attrition againſt each other, the eroſion of water, and various other accidents, clays, ſands, marles, and the component particles of freeſtone, ſandſtone, limeſtone, ſlate, and various other ſpecies of ſtone, have ariſen. Theſe are placed over each other in alternate and regular beds, parallel to each other, and being commonly mixed with marine exuviæ or other animal or vegetable remains, the hills formed of them are evidently of a date poſterior to thoſe already mentioned. In theſe, and in theſe only (or in plains formed of the ſame materials) coal is found, and there are ſcarcely any of them that do not contain it.

HILLS of this ſort are frequently interpoſed between the primæval mountains and the adjacent plains; ſometimes alſo they ſtand ſingle, and frequently they form the eminences that border rivers. It is to hills of this ſort, therefore, that we muſt direct our reſearches after coal. The thicker beds of it lie pretty deep, generally

generally from twenty-five to forty fathom, or more; and the ſureſt means of diſcovering them is to penetrate into theſe hills with an earth-borer, examining the ſtrata every two or three feet; if alternate ſtrata of indurated clay, ſand, ſlate, or ſandſtone occur, with iron ore or mica, we may be certain that coal will be found at a greater depth. The beds neareſt to the ſurface are generally either earthy, ſlaty or ſulphureous, and commonly thin and ſcanty, but under theſe, different beds of greater thickneſs and of a better ſort are found. Coals have alſo been ſometimes diſcovered by collecting the reddiſh or yellowiſh muddy water that runs down the ſides of hills after heavy rains; this water is collected in a pan ſuffered to ſubſide, and gently evaporated; if the ſediment appears covered with a black ſcum, the hills may be preſumed to contain coal.

Veins of coal are often mentioned, yet in reality coal is ſcarcely ever found in *veins*, but rather in *beds* or in *heaps*; though theſe beds, from a derangement cauſed by the occurrence of ſtone or matter of a different kind from that which forms the ſtrata, are ſometimes thrown into the form of a horſe-ſhoe, with the curvature downwards, and thus aſſume the appearance of a vein.

When a coal-mine is diſcovered, its *direction*, that is, its extent in the ſame horizontal line, and its *inclination*, that is, its fall beneath that line, are next to be traced; as it ſhould always be worked at right angles with its direction, and the ſhaft to drain off the water ſhould be ſunk in the loweſt part.

To find the inclination, three holes, each reaching to the bed of coal, are bored at the diſtance of ſix hundred feet from each other, forming an equilateral triangle, and the level and depth of each are taken. The higheſt is the ſtandard to which the diſtance downwards of the bed of coal under each hole is referred, that which is moſt diſtant in depth from the ſtandard being the loweſt. It is almoſt needleſs to add, that the boring ſhould be ſkilfully conducted, in order that the holes be perfectly perpendicular. A deſcription of the moſt improved earth-borer has lately been tranſlated from the German, and publiſhed by Doctor Mc. Nevin of this city [*].

In England beds of coal of leſs than two feet and an half in thickneſs are judged not worth working, but in Germany none exceeding ſix inches are neglected.

To convey a fuller idea of the ſtrata of earth or ſtone that generally accompany coal-mines, I ſhall here add an account of thoſe that are found in the principal coal-mines of Europe.

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[*] The price of boring in England is five ſhillings per fathom for the firſt ten fathoms, ten ſhillings per fathom for the next five fathoms, fifteen ſhillings per fathom for the next five, &c.

ENGLAND.

THE moſt conſiderable coal-mines in England are found in the counties of Northumberland and Durham on the eaſt, and thoſe of Lancaſhire and Cumberland on the weſt; they ſeem to extend acroſs the kingdom, or at leaſt to the mountains of Cumberland and Weſtmoreland. On the eaſtern coaſt, towards Newcaſtle, the land gently deſcends towards the ſea, but is here and there interſected with deep vallies, in the declivities of which the coaly ſtrata appear to have been firſt diſcovered. The ſtrata here lie in the following order*:

		Fathoms.	Feet.
1.	Mould or clay - - - -	4	—
2.	Brown ferruginous clay and mica -	3	—
3.	Whitiſh ſandſtone, intermixed with mica -	4	—
4.	Bituminous clay, mixed with pyrites and mica	8	—
5.	Coal - - - -	—	—½
6.	Stony clay, with ſand and mica -	4	—
7.	Coal - - - -	—	1
8.	Martial indurated clay, mixed with mica -	8	—
9.	Bituminous clay, like No. 4. - -	4	5
10.	The principal bed of coal, - - from	—	4 to 8.

THE principal bed is therefore about thirty-ſeven fathoms deep, but other beds are found ſtill lower.

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* Schwed. Abhandl. 1776.

WHITEHAVEN.

WHITEHAVEN.

	Fathoms.	Feet.
1. Clay	8	1½
2. Clay, mixed with ſand	11	5½
3. Culm and clay	3	1¼
4. Indurated clay	2	2½
5. Indurated clay, of a ſtony hardneſs	4	2
6. Coal of bad quality	1	4
7. Martial clay and mica	1	3¾
8. Coal	—	1½
9. Brown martial micaceous clay	—	1⅓
10. The ſame, but fatter	2	4
11. Apyrous or fire clay, called ſill	4	4¾
12. Clay, mixed with iron ore	6	2
13. Culm	—	3⅓
14. Micaceous ſandſtone	9	4⅓
15. Clay mixed with ſand and mica	8	5
16. Blue clay	—	2
17. Principal bed of coal	1	3
	59	3,75

THE ſtrata here extends from north to ſouth, but their inclination is from eaſt to weſt.

At ALFRETON COMMON *.

	Feet.	Inches.
1. Clay	7	—
2. Ratchil, or fragments of ſtone	9	—
3. Bind (an indurated clay)	13	4
4. Stony clay	6	—
5. Bind	33	8
6. Black ſtony clay	5	—
7. Bind	2	—
8. Stony clay	2	—
9. Bind	10	—
10. Coal	1	6
11. Bind	1	6
12. Stony clay	37	—
13. Bind	7	—
14. Smut (a black ſubſtance reſembling coal duſt)	3	—
15. Bind	3	—
16. Stony clay	20	—
17. Bind	16	—
18. Principal bed of coal	7	4
	184	4

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* Whitehurſt's Theory, page 211.

At HETRUVIA *in* STAFFORDSHIRE *.

1. Ratchil, or fragments of ſtone.
2. Limeſtone, one foot thick.
3. Sand.
4. Argillaceous ſtone.
5. Bind.
6. Coal.

At BAGELT *in* NORTH WALES †.

	Feet.	Inches.
1. Gravel and ſand - - -	45	—
2. Shale or Slate - - -	9	—
3. Argillaceous ſtone - - -	6	—
4. Slate - - - - -	1	—
5. Coal - - - - -	6	—
6. Clay - - - - -	9	—
7. Argillaceous grit or ſandſtone - -	44	—
8. Coal - - - -	2	3
9. Sandſtone - - - -	90	—
10. Slate - - - -	15	—
11. Coal - - - - -	15	—
	242	3

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* Whitehurſt's Theory, page 211.

† Ibid, page 242.

At LITCHFIELD *.

		Feet.	Inches.
1.	Black clay - - -	4	—
2.	Rotten ſtone - - - -	6	—
3.	Marle - - - -	18	—
4.	Thin coal - - -	4	—
5.	Black rock - - -	2	—
6.	Black bat (a marle) - - -	18	—
7.	White rock - - - -	6	—
8.	Clunch (a marle) - - -	21	—
9.	Grey rock - - -	3	—
10.	Black bat - - - -	3	—
11.	Coal - - - - -	30	—
		115	—

At COLEBROOK DALE †.

		Feet.	Inches.
1.	Brick clay - - -	3	—
2.	Potter's clay - - -	15	—
3.	Smut - - - - -	1	—
4.	Blue bat (an indurated clay or marle) -	3	6
5.	Sandſtone - - - -	7	—
6.	Coal - - - - -	4	—
7.	Potter's clay - - - -	3	—
8.	Beſt coal - - - -	3	—
9.	Brick clay - - - -	18	—
10.	Clod coal - - - -	2	6
11.	Clay - - - - -	18	—
12.	Flint coal - - - -	4	—
		82	—

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* In a letter from Mr. Godefroy de Villetaneuſe to Mr. Morand.

† Young's Annals of Agriculture, vol. iv. p. 168.

SCOTLAND.

SCOTLAND.

BALDO *near* FALKIRK*.

		Feet.	Inches.
1.	Clay	7	—
2.	Slate	33	—
3.	Limeſtone	3	—
4.	Slate and earth	6	—
5.	Coal	from 3	to 6
		52	—

GERMANY.

WETTEN *in the* DUTCHY *of* MAGDEBOURG †.

In Sophia Shaft.

		Feet.	Inches.
1.	Mould	1	6
2.	Coarſe brown martial ſlate	66	—
3.	Reddiſh blue micaceous ſandſtone	15	—
4.	Blue ſandſtone	21	—
5.	A calcareous ſtone filled with red and white flints	19	—
6.	Soft grey micaceous ſandſtone	18	—
7.	Bluiſh grey calcareous ſlate	13	6
8.	Micaceous ſlate	3	—
9.	Bituminous ſhiſtus	—	9
10.	Pyritous coal	3	6
11.	Bituminous ſhiſtus	—	1
12.	Pyritous coal	—	2
13.	Micaceous ſlate	9	—
14.	Blue micaceous ſandſtone	12	—
15.	Solid fine grained ſlate	4	—
16.	Principal bed of coal	1	—
		187	6

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* vi. Phil. Tranſ. Abr. Part II. page 223.

† 2d Gerhard Beytrage.

At LOBEGIN, *Dorothia Shaft* *.

	Feet.	Inches.
1. Mould - - -	2,33	—
2. Whitiſh yellow clay mixed with calcareous earth - -	24	—
3. Yellow ferruginous ſand - -	4,5	—
4. Blackiſh grey micaceous ſlate -	36	—
5. Soap rock mixed with quartz and flint -	26	—
6. Bituminous ſhiſtus - -	21	—
7. Coal - - -	4,5	—
	118,33	—

IN the country of Liege, coal is conſtantly ſurmounted by a hard argillaceous grit or ſandſtone, and lies in the form of a horſe-ſhoe.

THE coal-mine of Kladraw in Bohemia is but ſix fathoms under the turf, and covered with a white micaceous ſand.

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* 2d Gerhard Beytrage.

SWEDEN.

SWEDEN.

BOSCRUP *in* SCANIA *.

	Feet.
1. Mould and clay mixed with ſand	12
2. Grey ſandſtone, conſiſting of quartz with an argillaceous cement and iron ore	20
3. Coal	1
4. Black indurated martial clay	5
5. Yellowiſh ſandſtone	7
6. Black ſandy ſlate	3
7. Pyritous coal	2
	50

Near HELSINBURGH.

1. Sandſtone	36
2. Coal	2
3. Argillaceous ſlate	12
4. Sandſtone	6
5. Coal	1
	57

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* Schwed. Abhand. 1773.

FRANCE.

COAL has been diſcovered and worked in different parts of France; the beſt are found in Forez, Bourbonnois and Auvergne, it lies at inconſiderable depths and generally in heaps (and not in beds) on the ſides of hills, and therefore is eaſily extracted.

IRELAND.

DRUMGLASS †.

	Feet.
1. Clay and rubble ſtones	48
2. Soft argillaceous ſtone	30
3. Indurated clay	35
4. Slate	15
5. Coal	4,5
	132,5

BALLYCASTLE.

1. Whin ſtone (baſaltes)	60
2. Slate	24
3. Yellow freeſtone	42
4. Slaty coal	21
5. Hard grey freeſtone	90
6. Coal at preſent worked	5
	242

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† Whitehurſt, p. 246.